WHITE RIVER COUNTYLINE LEVEE SETBACK PROJECT

HABITAT MONITORING PLAN

RM 5.0 (8TH ST. E BRIDGE) TO RM 6.3 (A ST. SE BRIDGE)

US Army Corps of Engineers Reference No: NWS-2011-211

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Authors:
S.G. McCarthy[1], J.J. Latterell, T. Butler, J. O. Wilhelm, H.B. Berge, K. Akyuz,
and C.J. Brummer
King County Department of Natural Resources and Parks, Water and Land Resources Division
201 S. Jackson St, Suite 600, Seattle, WA 98104-3855

[1]Project Manager: Email: Sarah.McCarthy@kingcounty.gov; Phone: 206.477.4766

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EXECUTIVE SUMMARY

The Countyline Levee Setback Project is designed to reduce flood risk, restore natural river processes, reconnect the river to its adjacent floodplain, and improve fish habitat along 1.3 miles of the Lower White River between River Mile 5.0 and 6.3. This will be accomplished by removing an existing levee and revetment constructed in the 1910s along the left bank (looking downstream) between the A Street SE and BNSF Railway Bridges on the upstream end and the 8th Street E Bridge downstream end and constructing a new setback levee east of the wetland. The presence of top-of-bank levees and revetments in the Countyline Reach have constricted the channel for nearly one hundred years, thereby significantly altering the physical and biological character of the river, degrading fish habitat, and reducing salmon productivity in this reach. Relocation of the levee and installation of wood structures will restore riparian and aquatic habitat within the approximately 124-acre project area, allowing new and complex habitats to form and existing habitats to have a more direct connection to the river. Extensive revegetation of the left bank will jumpstart establishment of a wider riparian buffer for water quality and habitat protection.

The focus of this plan is habitat monitoring. Flood risk reduction parameters will be monitored by King County, and monitoring protocols will be described in the *Countyline Levee Setback Public Safety Site Management Plan* (King County, *in preparation*). Ecological parameters will be monitored for 10 years. Long-term monitoring will assure the project meets performance standards (e.g., 80% survival of installed vegetation, 50% increase in slow water edge habitat, etc.). A Before-After and Before-After-Control-Impact experimental design will be used.

The purpose of this monitoring effort is to:

1. Ensure the projects match design specifications (Implementation Monitoring),
2. Determine whether levee setback project actions are producing the intended effects on habitat conditions and threatened fishes (Effectiveness Monitoring), and
3. Improve design, construction, and maintenance practices using monitoring results (Adaptive Management).

General indicators of ecological project performance include channel movement, salmonid rearing habitat, floodplain inundation, wood loading, native riparian and invasive plant cover, and fish use. Examples of sampling methods include slow water edge habitat mapping at a range of flows, aerial photography of floodplain inundation, percent survival estimates for planted vegetation, percent cover estimates for native and invasive vegetation, and juvenile salmonid density in discrete habitat types.

Monitoring results will be used to measure ecological performance, inform site management, comply with environmental permits, and improve the effectiveness of similar projects in the future.

PROJECT SUMMARY

PROJECT LOCATION

The Countyline Reach of the Lower White River is bounded by the A Street SE and Burlington Northern Santa Fe (BNSF) Railway Bridges at the upstream end (River Mile 6.3) and the 8th Street East Bridge at the downstream end (RM 5.0), and is so named because it spans the King-Pierce County boundary (Figure 1). Portions of this reach fall within the City of Auburn, City of Pacific, City of Sumner, and unincorporated Pierce County. The Countyline Levee Setback Project (Project) will reconnect approximately 115 acres of floodplain to the White River channel, thereby reducing flood risk, restoring natural river processes, and improving fish habitat.

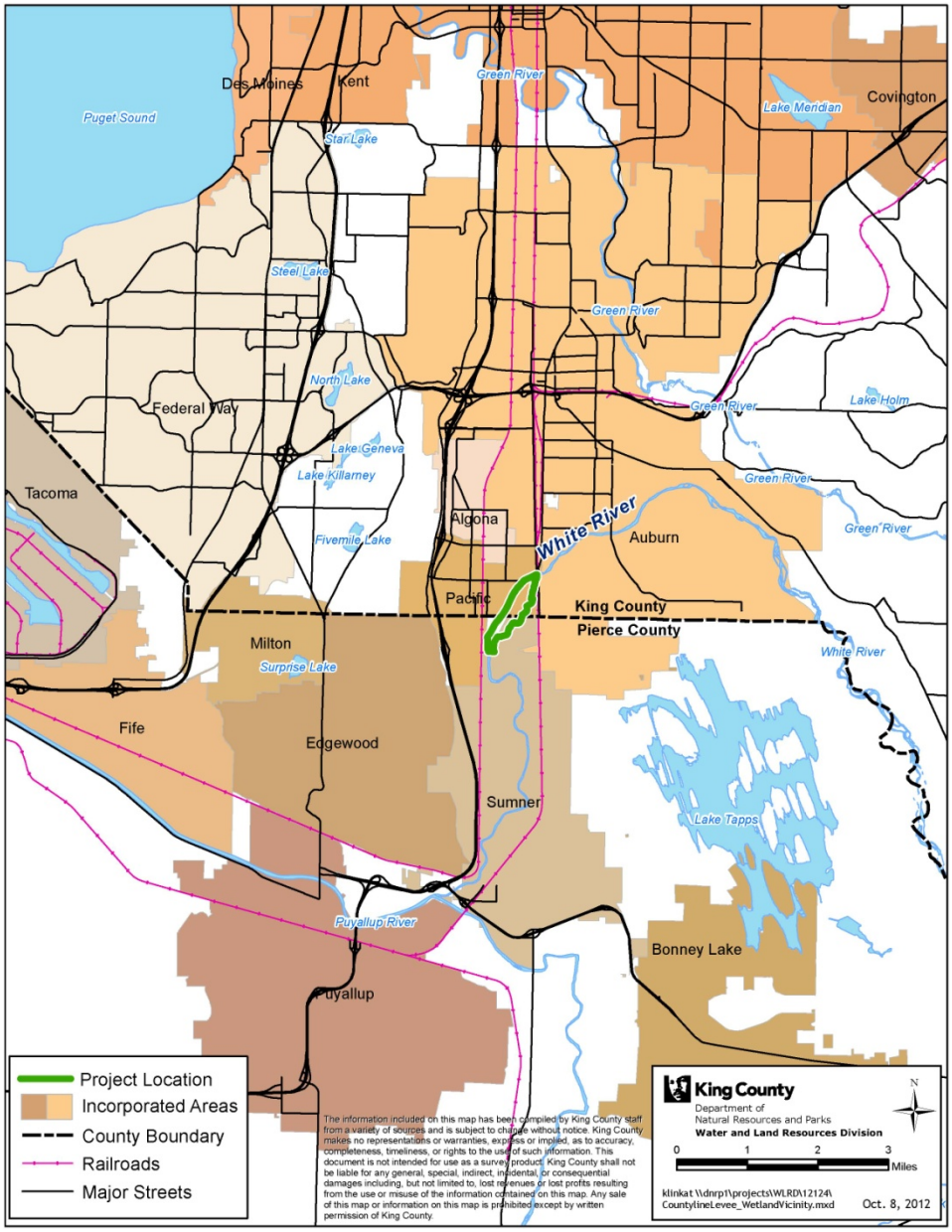


Figure 1. Project area vicinity map.

PROJECT SETTING

The lower White River is a highly modified system. The White River historically flowed into the Green River in the City of Auburn. In 1915, the Auburn Wall was built to permanently divert the White River into the Stuck River channel, a substantially smaller distributary channel that flowed to the Puyallup River. The new channel was enlarged by dredging to accommodate White River flows.

The White River carries a high sediment load because it originates on the Emmons and Winthrop glaciers on Mount Rainier and flows through a high gradient channel through most of its length, eroding through relatively new glacial and volcanic deposits. A marked decrease in channel gradient and valley confinement downstream of the White River canyon near the City of Auburn causes the river to deposit sediment, where a broad alluvial fan has formed. Channelization and construction of a confining levee system in the early 1900s in this broad and naturally depositional alluvial fan environment probably increased the vertical rates of sediment accumulation within the channel. The historical human response to this was a consistent river management program of sediment removal to maintain river channel capacity (Herrera 2010). Cessation of gravel removal in the late 1980s probably contributed to channel aggradation within the confines of the levees in the lower reaches of the White River.

PROJECT JUSTIFICATION

Flood Risk Reduction

Problems associated with channel aggradation became increasingly clear during the January 2009 flood, when the U.S. Army Corps of Engineers released up to 11,700 cubic feet per second (cfs) of water from behind Mud Mountain Dam, as had been done in past floods. However, flood damage in 2009 along the Countyline Reach of the Lower White River was much greater than damage during previous floods, with flood damage to over 100 homes in the White River Estates neighborhood, along with several commercial businesses on Butte Avenue and the Megan's Court Apartments near the Pacific City Park. On the left bank, floodwaters inundated agricultural lands in the City of Sumner and overtopped 8th Street E (also known as Stewart Road SE); a major arterial.

Subsequent investigations by King County and Herrera Environmental Consultants have revealed that the channel flood capacity in the Countyline Reach of the White River has decreased from 25,000 cfs in the 1980s (when channel capacity was maintained by dredging) to 8,000 cfs. The channel is projected to completely fill with sediment at the King-Pierce county line in about 15 years, significantly increasing the flood risk for commercial, industrial, and residential parcels adjacent to and downstream of the project area. Analyses indicate that gravel removal would have a relatively minor and short-lived effect on reducing flood water levels in the Countyline Reach, especially when compared with reduced flood levels achieved with a setback levee. The 8th Street E Bridge in Sumner, which has two in-channel piers and little remaining clearance from its low chord, significantly constricts flows and will be at increased risk of overtopping or failing during high flows. The left bank levee currently overtops near the county line at 3,500 cfs, and flows escape the wetland at 7,500 cfs, flowing down 142nd Street and over 8th Street East. The most recent hydraulic model of the 100-year flood event shows one third of the flow (5,000 cfs) moving through this area (Herrera *in preparation*).

Habitat Restoration

The levees and their riprapped banks have reduced access to side channels and floodplain wetlands, reduced the quality of channel edge and riparian habitat for fish, aquatic species, and other riparian wildlife, reduced the supply of large wood to the active river channel, and changed the way the river transports and deposits sediment. Channelization associated with the levees has shortened the White River's length.

The lower White River today is geomorphologically simple relative to historic conditions. River habitat is mostly fast-water riffles or runs, with very few pools or off-channel habitats. The lack of slow water areas with good cover results in poor habitat for juvenile salmon, making the lower river less productive for many species at critical life stages.

The need for rearing and off channel salmonid habitat in this reach of the White River is documented in the Puyallup Watershed (WRIA 10) and Chambers/Clover Creek Watershed (WRIA 12) Salmon Habitat Protection and Restoration Strategy (Pierce County 2008). This report notes:

> *"The loss of floodplain habitat that is limiting the performance of Puyallup and White River Chinook is due to the channelization and confinement of the river within an extensive system of revetments and levees (flood works) in the mainstems of the Puyallup, White, and Lower Carbon Rivers. Preferred projects in the mainstem areas would protect and restore floodplain habitat such as side channels and backwaters." (Page 17)*

The Strategy identifies lack of this type of habitat as a bottleneck in meeting basin-wide recovery goals for Chinook salmon and concludes:

> *"Levee setbacks and estuarine habitat creation are the most beneficial types of actions needed for recovery of Chinook in WRIA 10." (Page 21)*

WRIA 10/12 conducted a levee setback feasibility study in 2008, and the Countyline Levee Setback Project was a highly ranked project for its potential to recover lost flood storage and provide aquatic habitat for juvenile salmon rearing habitat (GeoEngineers 2008). The project was also added to the WRIA 10/12 3-Year Implementation List and ranked as having a high benefit to salmon.

HABITAT GOAL AND OBJECTIVES

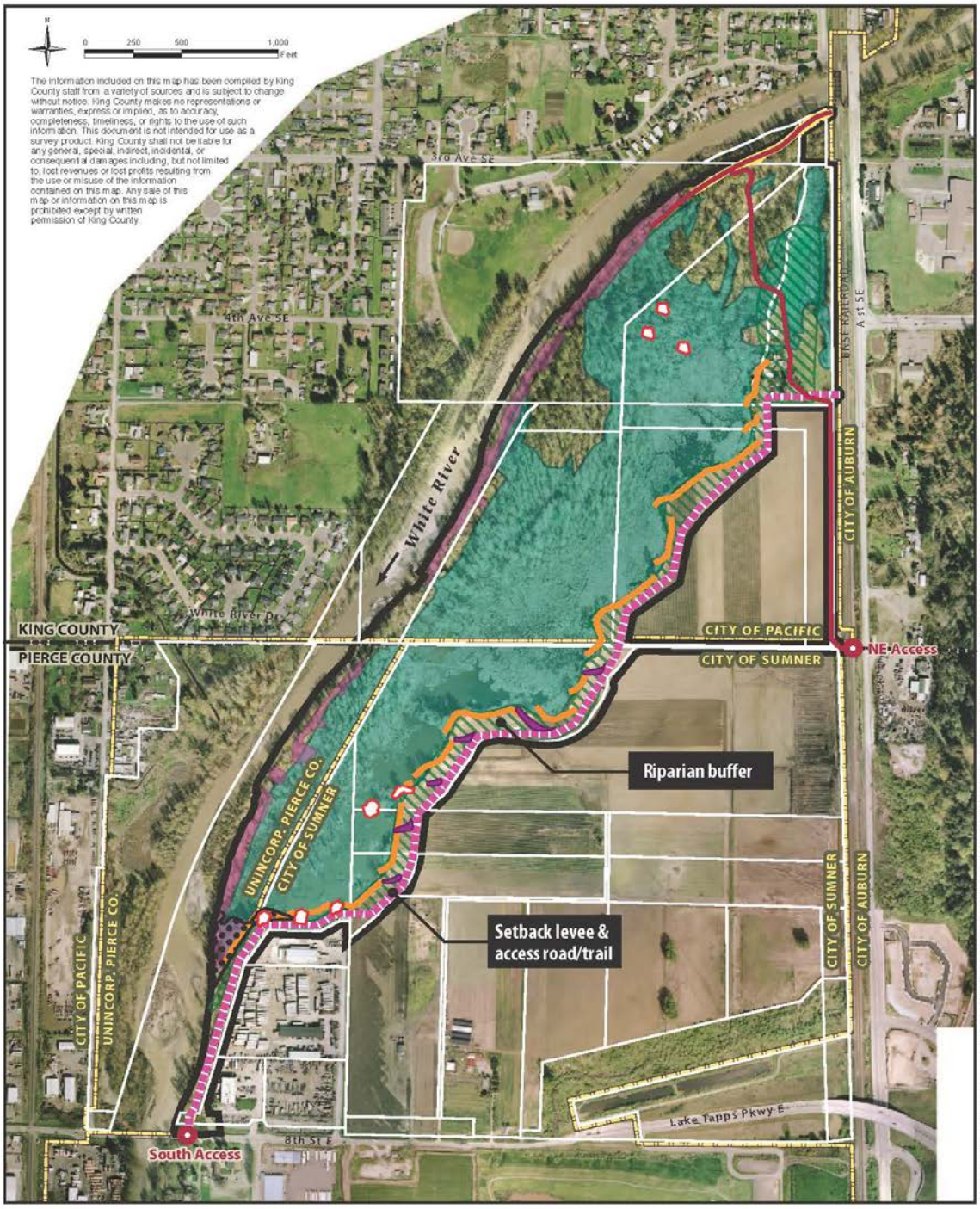
The restoration goal of the Countyline Levee Setback Project was written to complement goals in both the WRIA 10/12 Salmon Habitat Protection and Restoration Strategy (Pierce County 2008) and the King County Flood Hazard Management Plan (FHMP, King County 2006). Protection and reconnection of floodplain habitat and fluvial processes is expected to support the productivity of freshwater life stages of salmonids, and floodplain reconnection projects have been identified by the Puyallup/White Watershed (WRIA 10) as the highest priority for lower White River Chinook habitat protection and restoration (Pierce County 2008). Floodplain reconnection and levee setbacks are key strategies in the FHMP for reducing flood risks while working with natural riverine processes. These techniques are also thought to be less costly over time than traditional structural approaches to flood hazard management (King County 2006).

The habitat restoration goal and related objectives of the Countyline Levee Setback Project are:

> **Goal:** Restore riverine processes and functions to the lower White River and its floodplain within the project area in order to enhance salmonid rearing habitat, in particular for spring and fall Chinook, coho, and steelhead.
>
> **Objectives:**
>
> 1. Allow natural channel movement within the project area by removing and setting back the existing levee along the left bank.
> 2. Encourage the formation of off-channel rearing habitat (pool complexes and side-channels), such as through installation and future natural recruitment of large wood, that will promote the return of the complexity, diversity, and morphology found in an unconstrained floodplain.
> 3. Provide off-channel flood refuge for salmonids by allowing a more natural frequency of inundation of the floodplain complex during flood events within the project boundaries.
> 4. Protect existing mature riparian buffer areas and restore a corridor of mature riparian vegetation within the project boundaries to provide shoreline and stream channel shading, invertebrate prey supply, and large wood recruitment.

PROJECT ACTIONS

Because the lower White River is highly modified and constricted, the approach to resolving existing flood risks focuses on increasing flood flow and sediment load capacity. The strategy is two-fold: (1) acquire land rights (fee or easements), and (2) implement capital improvements to modify levees and retrofit revetments so that the river is reconnected to its floodplain. This will increase flood conveyance and storage as well as accommodate sediment deposition. Returning the lower White River to a more naturally functioning floodplain will improve aquatic and wildlife habitat. Levees will be reconstructed along an alignment set back from the current active channel, large wood structures will be installed to disperse adversely erosive flows and provide complex habitat, and native vegetation will be planted to eventually provide a healthy riparian buffer (Figure 2).



Preliminary Design

WHITE RIVER (COUNTYLINE)
LEVEE SETBACK PROJECT

June 2013 (Based on 60% design)

Figure 2

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section

- Project Ingress/Egress
- Setback Levee & Access Road/Trail
- Access Road
- Bioengineered Revetment
- Project Area Boundary
- Engineered Log Structure
- Levee Resurfacing
- Floodplain Roughening Structures and Hummocks
- Parcel of Interest
- Wetland
- Revetment & Levee Removal
- Planting Plan Area
- Culvert Removal, Outlet Channel & Fill Removal
- Incorporated Area Boundary
- County Boundary

PERFORMANCE STANDARDS

Monitoring objectives and performance standards are designed to determine project effectiveness (Table 1).

Table 1. Performance sta ndards.

Category	Indicator	Objective	Performance Standards[1]	Adaptive Management
Project Implementation	As-built condition	Project is constructed according to design specifications and regulatory conditions.	As-built condition satisfies design objectives.	Adjustments to meet design specifications made during construction.
Channel Dynamics	Movement	Channel complexity (e.g., sinuosity, formation of multiple channels) will increase.	New channel(s) form outside of the present (pre-project) active channel.	Consider measures to initiate a flow path through appropriate means.
Habitat Benefit	Aquatic habitat	The area of slow-water edge habitat will increase.	Sum of slow-water (<1.5 ft/sec) bar, bank, backwater and side channel area increases by >50%, relative to baseline condition.	Project objective not met.
		The area of floodplain inundation will increase.	Floodplain inundation within the project area will increase after project construction, as measured between February 1 and March 31 utilizing aerial photography.	Consider measures to promote floodplain inundation.
	Wood	Wood loading will increase over baseline condition.	Wood loading (natural and placed) on site meets or exceeds NMFS recommendation for properly functioning condition (>80 pieces/mile; NMFS 1996).	Project objective not met.
	Riparian cover	Installed plants survive.	80% survival[2] at end of Year 1 growing season for all installed trees and shrubs (excluding stakes)[3].	Additional planting or maintenance needed.
		Installed plants, as well as volunteers of desirable native woody species, form a dense canopy cover.	Cover by installed trees and shrubs, including cover by volunteers of desirable native woody species: Year 2 at least 15%, Year 3 at least 20%, Year 5 at least 40%, Year 7 at least 60%, and Year 10 at least 75%.	Additional planting or maintenance needed.
		Biorevetment allows a vegetated riparian buffer to establish between river and setback levee.	Average vegetated riparian buffer width of 75 feet.	Reconsider design approach in similar settings.
	Invasive cover	Invasive plant cover is minimized due to native revegetation and weed control.	Less than 10% invasive cover (non-regulated noxious weeds and weeds of concern) in planted areas (5% for KC Class A noxious weeds, bindweed, and knotweed). Less than 25% reed canary grass on site as a whole.	Additional maintenance needed. If reed canarygrass performance standard exceeded, plant areas with willow (cultural control).
	Wetlands	Wetland area temporarily impacted by construction is restored.	1.08 acres temporary impacts in Wetlands A and B restored to aquatic habitat condition.	To be determined depending on conditions.
Fish use	Habitat preference	Juvenile salmonids preferentially use low velocity edge habitat (specifically backwaters and side channels).	Juvenile salmonid density (or frequency of occurrence) is highest in backwaters and side channels, compared to other edge types.	Revise habitat priorities in future design considerations in Lower White River.
	Habitat capacity	Habitat capacity is increased by increasing low velocity edge habitat.	Habitat capacity at project site – estimated as the product of the average density of juvenile salmonids in edge habitats and the area of edge habitat (by type) at median rearing flows increased by >50% compared to baseline.	Project objective not met

[1]Performance assessed over 10-year monitoring period, unless otherwise noted.

[2]Only installed plants count towards achieving the Survival Performance Standard; volunteers do not count.

[3]Plant survival and cover on top of the apex logjams will be assessed when access is feasible.

MONITORING STRATEGY

The focus of this plan is habitat monitoring. Flood risk reduction parameters will be monitored by King County, and monitoring protocols will be described in the *Countyline Levee Setback Public Safety Site Management Plan* (King County, *in preparation*). This monitoring plan will help evaluate the effectiveness of project elements intended to improve natural processes that create and sustain productive aquatic habitat.

MONITORING PURPOSE

An understanding of natural floodplain processes and baseline conditions is essential for planning river and floodplain restoration projects and for evaluating effectiveness (Pess et al. 2005; Ward et al. 2001). Because the science of floodplain restoration is still evolving, actions should be viewed as experimental manipulations linked to explicit hypotheses (Pess et al. 2005). The purpose of this monitoring plan is to evaluate whether a large-scale floodplain reconnection project on the Lower White River effectively meets the stated habitat goal and objectives and is able to meet the performance standards.

The purpose of this monitoring plan is to:

1. Ensure the projects match design specifications (Implementation Monitoring),

2. Determine whether levee setback project actions are producing the intended effects on habitat conditions, watershed processes, and threatened fishes (Effectiveness Monitoring), and

3. Improve design, construction, and maintenance practices using monitoring results (Adaptive Management).

AUDIENCE

The primary audiences for implementation and effectiveness monitoring results include:

1. King County staff – Results will be shared to inform future project design, construction, and monitoring protocols, as well as project maintenance needs. The reporting format includes presentations, monitoring reports, and access to real-time data.

2. Regulatory agencies – Monitoring results will allow regulatory agencies to determine whether performance standards are being met, as well as inform review of future projects with similar elements. Monitoring reports will be submitted to the US Army Corps of Engineers in Years 1, 2, 3, 5, 7, and 10.

3. Funding agencies and project stakeholders – Monitoring results will provide funding agencies and project stakeholders with the information necessary to determine whether funding agreements are being followed, as well as to evaluate the effectiveness of the

project at meeting funding priorities. The reporting format includes presentations and monitoring reports.

4. Scientific community – This study will add to a growing body of research into the effects of large-scale floodplain reconnection projects on channel processes and habitat conditions, as well as the efficacy of levee setbacks for flood risk reduction in depositional rivers.

MONITORING DESIGN

The project reach will be monitored before and after project implementation to measure changes in physical and biological processes as well as to assess the ability of the project to meet its stated performance standards. A control reach immediately upstream between the R Street SE and A Street SE Bridges in Auburn will be used where appropriate to account for variability related to environmental fluctuations (Roni et al. 2005).

MONITORING TASKS AND OBJECTIVES

Indicators, or evaluation metrics, are proposed for each performance standard (Table 2). These indicators are intended to be used for effectiveness analyses (comparisons between time periods) and interpretation of the overall project success.

Table 2. Indicators and monitoring methods for evaluating project effectiveness.

Category	Indicator	Performance Standard	Task	Monitoring Method	Timing (Years)	Output
Project Implementation	As-built condition	As-built condition satisfies design objectives.	1	Manage construction to ensure project satisfies design objectives; Produce record drawings.	Immediately post-construction	Record drawings
Channel Dynamics	Movement	New channel(s) form outside of the present (pre-project) active channel.	2	LiDAR, aerial photography, and field survey	1, 3, 5, 10 (timing may be adjusted based on high flow events)	Mapped channel forms
Habitat Benefit	Aquatic habitat	Sum of slow-water (<1.5 ft/sec) bar, bank, backwater and side channel area increases by >50%, relative to baseline condition.	3	Map slow water areas on channel margins at flows representing 50th, 75, and 90th percentile flows during Jan-Jun	1, 3, 5, 10	Change in edge habitat area relative to baseline
		Floodplain inundation within the project area will increase after project construction, as measured between February 1 and March 31 utilizing aerial photography.	4	Georeferenced aerial photography and field ground-truthing	1, 3, 5, 7, 10; additional photography may be collected during and following high flow events	Georeferenced photograph of inundated area
	Wood	Wood loading (natural and placed) on site meets or exceeds NMFS recommendation for properly functioning condition (>80 pieces/mile; NMFS 1996).	5	Object-based image analysis (based on LiDAR and orthophotos) and field survey	1, 5, 10	Estimates of wood loading
	Riparian cover	80% survival[2] at end of Year 1 growing season for all installed trees and shrubs (excluding stakes)[3].	6	Fixed plots	1, 2, 3, 5, 7, 10	Percent survival of installed plants
		Cover by installed trees and shrubs, including cover by volunteers of desirable native woody species: Year 2 at least 15%, Year 3 at least 20%, Year 5 at least 40%, Year 7 at least 60%, and Year 10 at least 75%.	7	Fixed plots	1, 2, 3, 5, 7, 10	Percent cover of native installed and volunteer woody vegetation (trees and shrubs)
		Average vegetated riparian buffer width of 75 feet.		See task 4	1, 5, 10	Minimum, average, and maximum buffer width
	Invasive cover	Less than 10% invasive cover (non-regulated noxious weeds and weeds of concern) in planted areas (5% for KC Class A noxious weeds, bindweed, and knotweed). Less than 25% reed canary grass on site as a whole.		See task 7	1, 2, 3, 5, 7, 10	Percent cover of invasive plants
	Wetlands	1.08 acres temporary impacts in Wetlands A and B restored to aquatic habitat condition.		See task 4	1	Wetted area
Fish use	Habitat preference	Juvenile salmonid density (or frequency of occurrence) is highest in backwaters and side channels, compared to other edge types.	8	Sample juvenile salmonids in edge habitat during rearing period	1, 3, 5, 10	Relative abundance of juvenile salmonids in discrete habitat types
	Habitat capacity	Habitat capacity at project site – estimated as the product of the average density of juvenile salmonids in edge habitats and the area of edge habitat (by type) at median rearing flows increased by >50% compared to baseline.		See tasks 3 and 10	1, 3, 5, 10	Change in habitat capacity

MONITORING SCHEDULE

All indicators will be sampled at the project site (Table 3). A control area immediately upstream may be established and monitored for channel dynamics, slow water edge, and fish monitoring.

Table 3. Monitoring schedule.

Task	Objectives	Pre-Construction Baseline	Post-Construction Baseline	Year 1 2017	Year 2 2018	Year 3 2019	Year 4 2020	Year 5 2021	Year 6 2022	Year 7 2023	Year 8 2024	Year 9 2025	Year 10 2026
1	Record Drawings		X										
2	LiDAR/air photos*	X		X		X		X					X
3	Edge habitat	X		X		X		X					X
4	Aerial photography*			X		X		X		X			X
5	Wood loading	X		X				X					X
6	Plant survival			X									
7	Percent vegetative cover			X	X	X		X		X			X
8	Fish sampling	X		X		X		X					X

*Additional sampling may be conducted during and following high flow events

MONITORING PROTOCOLS

PROJECT IMPLEMENTATION

Upon completion of the projects, the design drawings will be updated to become record drawings. The information for these record drawings comes from the Contractor's daily record drawings as well as the Project Representative's field records (daily records, photographs, inspection reports, field directives, and possible change orders) and post-construction site survey. Record drawings represent the best information available as to where improvements and changes from the original design have been made during construction due to unanticipated conditions encountered in the field. The record drawings will show sufficient detail to allow location of these improvements and changes for future monitoring or maintenance.

CHANNEL DYNAMICS

The river channel may adjust to restoration with increased channel complexity, manifested by increased channel sinuosity or increased occurrence of multiple channels, or both. Channel complexity strongly affects the physical habitat template for salmonids and riparian forests. Geomorphic processes that result in increased channel complexity include lateral channel movement, changes in plan form channel pattern, increases in the rate and frequency of meandering, neck and chute cutoffs, large scale avulsions or reoccupation of old channels resulting in a new main channel or secondary channel (anastamosing). Channel dynamics monitoring will focus on the formation of new channels outside of the present (pre-project) active channel; it will also characterize channel complexity by measuring channel sinuosity (channel centerline length divided by valley centerline length) and documenting the occurrence of multiple channels.

Channel location, channel pattern and channel features such as gravel bars will be mapped annually by interpreting aerial photos, augmented by field inspection and (less frequent) ground surface elevations from LiDAR. Mapped channel locations will allow documentation of the formation of new channels outside of the present active channel and the occurrence and frequency of multiple channels. Air photo analysis also will be used to measure changes in the location of the active channel centerline between consecutive years along cross-valley transects spaced at intervals scaled to channel width (Latterell et al. 2008). These measurements will allow calculation of channel sinuosity and quantification of geomorphic processes such as annualized estimates of channel movement, by mechanism.

HABITAT

General Site Conditions and Amphibian Use

Surveyors will note general site and habitat conditions on field datasheets. This should include observed fish and wildlife use (direct observation of live or dead animals or indirect observation of prints, scat, etc.), general patterns of vegetation condition, invasive vegetation, illegal use or dumping, deformation or damage (movement of installed wood, bank erosion, etc.), and anything else considered worth noting. In addition, post-project amphibian breeding surveys will be conducted in Years 1, 5, and 10 to document habitat use by lentic breeding amphibians (Richter and Ostergaard 1999; Thoms et al. 1997). Because the project has the potential to adversely affect lentic breeding amphibians, a project performance standard was not associated with this monitoring effort. Rather, the information will be used to document change in breeding area and use and inform future project considerations in similar settings.

Aquatic Habitat

The primary focus of aquatic habitat surveys will be to determine how the amount, type, and distribution of low-velocity edge habitat (hydraulic refuge) changes with flow before and after restoration. Edge habitats are generally characterized by shallow and low velocity water and fine substrate and have been shown to be important for juvenile salmonids, particularly Chinook (Hillman et al. 1987; Bjornn 1971). This sampling will focus on bars, banks, backwaters and side channels (Beechie et al. 2005). Edge habitat mapping will be conducted at flows representing 50th, 75, and 90th percentile flows during Jan-Jun. Edge habitat will be classified, mapped and measured with two downriver passes; one along the left bank and the other along the right. The margin of the wetted channel will be mapped on foot by GPS. The midstream (waterward) margin of the edge habitat will be located with a flow meter – where water velocity is approximately <1.5 ft/sec- and the slow-water boundary mapped at multiple points by GPS. Points and water margins will be transferred to a GIS and to permit the area, number, and distribution of low-velocity edges to be quantified for bars, banks, backwaters, and side channels, and then plotted against corresponding discharge levels.

Inundation area will be monitored in the project area using georeferenced aerial photography between February 1 and March 31 of each monitoring year. Total inundated acreage will be

calculated in GIS. Field survey using GPS may be necessary for heavily vegetated areas and for ground-truthing in early monitoring years.

Wood

Wood loading will be characterized using field surveys and aerial photo interpretation. Field surveys of large wood will follow methods specified by Montgomery (2008) and Latterell (2012). Aerial photos and object-based image analysis may also be used to replace or supplement field surveys. Logjams will be mapped as a single unit, and large isolated pieces (i.e., E4s and larger; Montgomery 2008) will be mapped separately. In each case, the point will be given several attributes based on photo interpretation. The trapping location will be noted as mainstem, side channel, backwater, floodplain, or wetland. The physical function of jams and pieces will be noted as pool scour, bar formation, bank stabilization, flow splitting, meander geometry, and sediment trapping. The ecological functions will be noted as vegetation regeneration, juvenile salmonid cover, juvenile salmonid rearing habitat, and adult holding habitat. The size of each individual piece will be described using the alphanumeric code from Montgomery (2008), ranging from E4 to G7. The river mile location will also be noted.

Riparian and Invasive Plant Cover

Vegetation monitoring transects will be established in disturbed areas to evaluate the success of planted vegetation and to estimate the rate at which native and invasive trees colonize bare ground. Transects will be established within five strata (four per stratum): naturally-formed gravel bars (GB), constructed depositional bars behind engineered log jams (ELJ), riparian buffer (RB), off-channel forested areas (OC), and levee slopes (LS). Transects will not cross strata. Transects will be established directionally to maximize transect length with a minimum transect distance of 30-m (max 50-m). A photo monitoring point will be established at the beginning and end of each transect, looking back along the transect. Some transects in the active floodplain and channel (GB, ELJ, OC) may become inaccessible as channel complexity increases following construction.

Percent cover trees, shrubs, groundcover will be measured using circular plots with a 3-m radius at three locations, the beginning, middle, and end, of each transect. Percent cover will be estimated using Daubenmire cover classes to ensure repeatability of measurements. Estimates of cover will be categorized into native and invasive plant cover classes.

Tree regeneration will be measured at five locations along the transect within 1-m^2 quadrats. Trees will be identified to genus and classified as seedling versus non-seedling. Invasive species frequency will be measured in five 4-m^2 quadrats established using the same point as the tree regeneration quadrats. Invasive species will be identified to genus and classified as seedling or non-seedling within these quadrats.

Wetlands

Temporary construction fill in wetlands will be removed following construction. The impacted areas will be monitored in Year 1 to determine whether the area reverted to aquatic habitat condition (flowing or ponded water).

Fish Use

Habitat Preference

The study area has the potential to provide valuable rearing habitat for salmonids which is limited in the Lower White River. Fish monitoring will focus on quantifying changes in the density of juvenile Chinook, steelhead, and coho, and will document use of the site by other species such as bull trout.

Seining will be used as the primary sampling technique in mapped habitat units to determine the relative importance of each habitat type for each species and life stage. If it is not possible to sample all of the habitats at the project site, then a stratified random sample will be selected for surveys proportional to the type of habitats that are available in the study reach. Surveys will target Chinook and steelhead juveniles in particular, and are therefore proposed to occur during the spring and late summer/early fall.

Habitat Capacity

Habitat capacity, estimated as the product of the average density of juvenile salmonids in edge habitats and the area of edge habitat (by type) at the targeted rearing flows, is summed across all habitats available at the project site. The habitat capacity will be calculated for each period when edge mapping and fish sampling occur, and compared with baseline conditions sampled during the same season.

Adaptive Management

Specific adaptive management strategies are outline in Table 1. The expected outcomes of this monitoring effort are:

- Quantitative evaluation of the effectiveness of a large-scale levee setback and floodplain reconnection project on the Lower White River,
- Improved certainty in the outcome of large-scale levee setback projects in mainstem rivers,
- Empirical understanding of how fish, habitat, and watershed processes respond to a suite of restoration actions, and
- Increased understanding of the appropriateness of specific monitoring methods for evaluating floodplain reconnection project effectiveness.

In general, if the evidence confirms the monitoring hypotheses, the actions taken and techniques employed will be viewed as successful and worthy of application in future (similar) projects and

monitoring studies. If the hypotheses are not confirmed, or the evidence remains very weak, the accumulated knowledge will be used to explain (or speculate) why the desired outcomes were not achieved. Lessons from both ‘successes’ and ‘failures’ are valuable products from this monitoring effort; these lessons will be summarized in reports and presentations. The results of this monitoring will likely provide valuable lessons and insights that can be applied to similar projects and studies in the future, and to guide adaptive management decisions.

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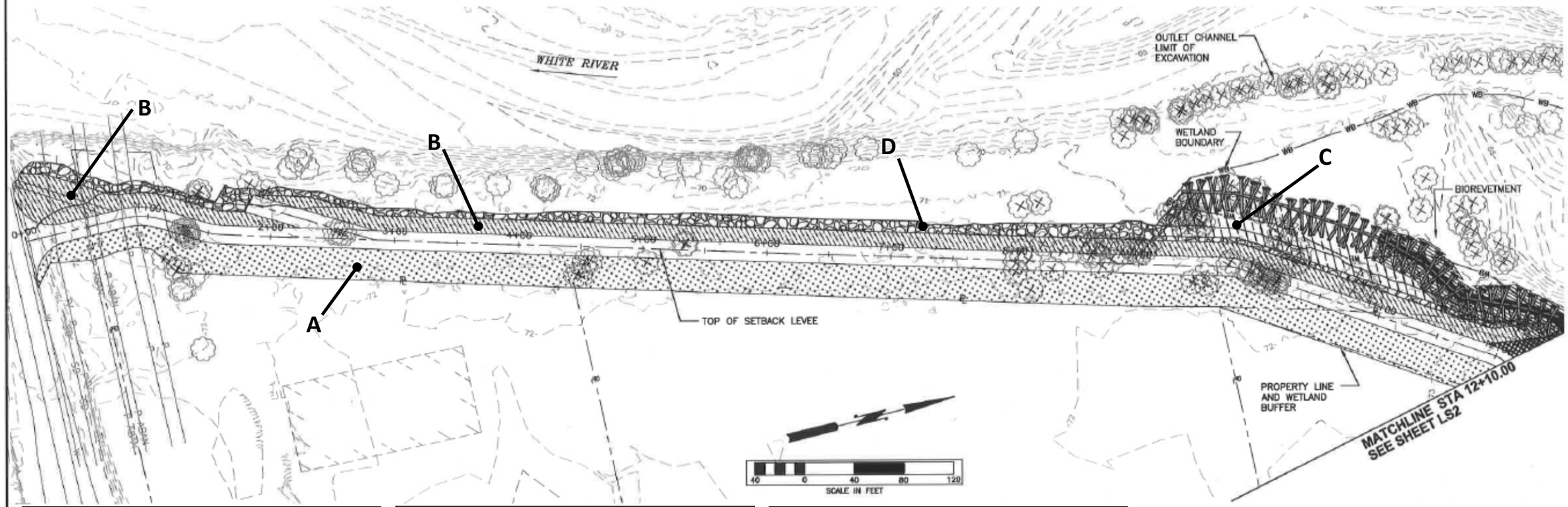
APPENDIX A. PLANTING PLAN

(planting plan sheets excerpted from 60% design drawings)



A. LANDWARD LEVEE SLOPE (152,170 ft²)

Common Name	Spacing	Stock Type	Quantity
Saskatoon	6	GAL	423
Hazelnut	6	GAL	1,057
Red fescue (Note 1)	14 lbs/ac	SEED	49
Oceanspray	6	GAL	1,691
Shore pine	25' L	GAL	240
Sword fern (Note 1)	4	GAL	951
Snowberry	6	GAL	1,057
Fringe cup (Note 1)	4	POT	476
		Total Plants:	5,942

B. WATERWARD LEVEE SLOPE WET (67,881 ft²)

Common Name	Spacing	Stock Type	Quantity
Vine maple	6	GAL	189
Red alder	12	GAL	94
Lady fern (Note 2)	4	GAL	424
Red twig dogwood	6	GAL	471
Hazelnut	6	GAL	189
Red fescue (Note 2)	14 lbs/ac	SEED	22
Indian plum	6	GAL	189
Nootka rose	4	GAL	424
Salmonberry	4	GAL	424
Hooker's willow	6	LS3	189
Sitka willow	6	LS3	189
Red elderberry	6	GAL	189
Snowberry	6	GAL	471
Western redcedar (Note 2)	25' L	GAL	154
Piggy-back plant (Note 2)	4	POT	212
		Total Plants:	3,829

C. WETLAND BUFFER WET (230,480 ft²)

Common Name	Spacing	Stock Type	Quantity
Black cottonwood	10	LS3	1,613
Red alder	10	SD, GAL	461
Western redcedar	10	PL, GAL	230
Cascara	6	SD, GAL	640
Hooker's willow	6	SD, LS3	640
Sitka willow	6	SD, LS3	640
Vine maple	6	TR, GAL	640
Nootka rose	4	SD, GAL	1,441
Red twig dogwood	6	TR, GAL	1,280
Salmonberry	4	TR, GAL	1,441
Lady fern	4	GAL	1,441
		Total Plants:	10,468

D. ROCK-FACED LEVEE (1,731 ft²)

Common Name	Spacing	Stock Type	Quantity
Scouler's willow (Note 3)	2 L	LS6	866

NOTES:

1. Plant shore pine in straight line 25' o.c. in mid-slope position only. Seed first 3' of slope adjacent to road with red fescue; next 3' to be planted with sword fern and fringe cup only.
2. Plant Western redcedar 25' o.c. in undulating line on mid-lower slope position. Seed first 3' of slope adjacent to road with red fescue; next 3' to be planted with lady fern and piggy-back plant.
3. Install 6' to 8' long, 1" to 2" live willow stakes 2' o.c. in single layer in 2" topsoil immediately above rock layer per design drawings.

LEGEND:

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

HABITAT MONITORING PLAN SHEETS: MODIFIED FROM 60% DRAWINGS.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60% 5-2013

NUM.	REVISION	BY	DATE

APPROVED: JEANNE STYPULA, PE 4-2013
PROJECT MANAGER: CHRIS BRUMMER, PE 4-2013
DESIGNED: KATE AKYUZ 4-2013
ECOLOGIST: SARAH McCARTHY 4-2013
DESIGN ENTERED: LICA DULAN 4-2013

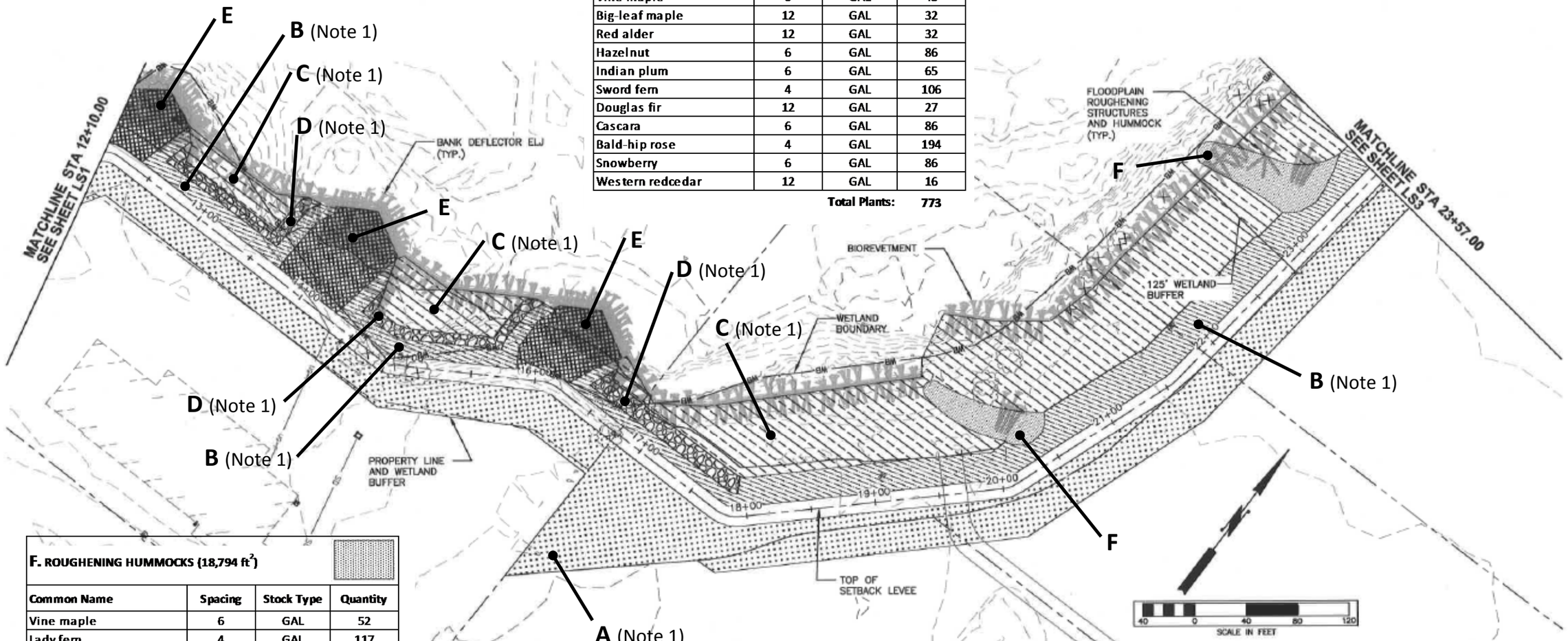
SRFB # RCO 087-1910C
PROJECT No. 1112049 (FL9001)

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
Christie True, Director

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION
PLANTING PLAN

SHEET 62 OF 69 SHEETS
LS1

E. BANK DEFLECTOR ELJs (15,497 ft²)			
Common Name	**Spacing**	**Stock Type**	**Quantity**
Vine maple	6	GAL	43
Big-leaf maple	12	GAL	32
Red alder	12	GAL	32
Hazelnut	6	GAL	86
Indian plum	6	GAL	65
Sword fern	4	GAL	106
Douglas fir	12	GAL	27
Cascara	6	GAL	86
Bald-hip rose	4	GAL	194
Snowberry	6	GAL	86
Western redcedar	12	GAL	16
		Total Plants:	**773**



F. ROUGHENING HUMMOCKS (18,794 ft²)			
Common Name	**Spacing**	**Stock Type**	**Quantity**
Vine maple	6	GAL	52
Lady fern	4	GAL	117
Red twig dogwood	6	GAL	104
Sword fern	4	GAL	117
Black cottonwood	12	LS3	131
Cascara	6	GAL	52
Nootka rose	4	GAL	117
Salmonberry	4	GAL	117
Hooker's willow	6	LS3	104
Sitka willow	6	LS3	104
		Total Plants:	**1,018**

NOTES:

1. See Sheet LS1 for planting tables for zones A, B, C, and D.

LEGEND:

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

HABITAT MONITORING PLAN SHEETS: MODIFIED FROM 60% DRAWINGS.

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5-2013

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COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
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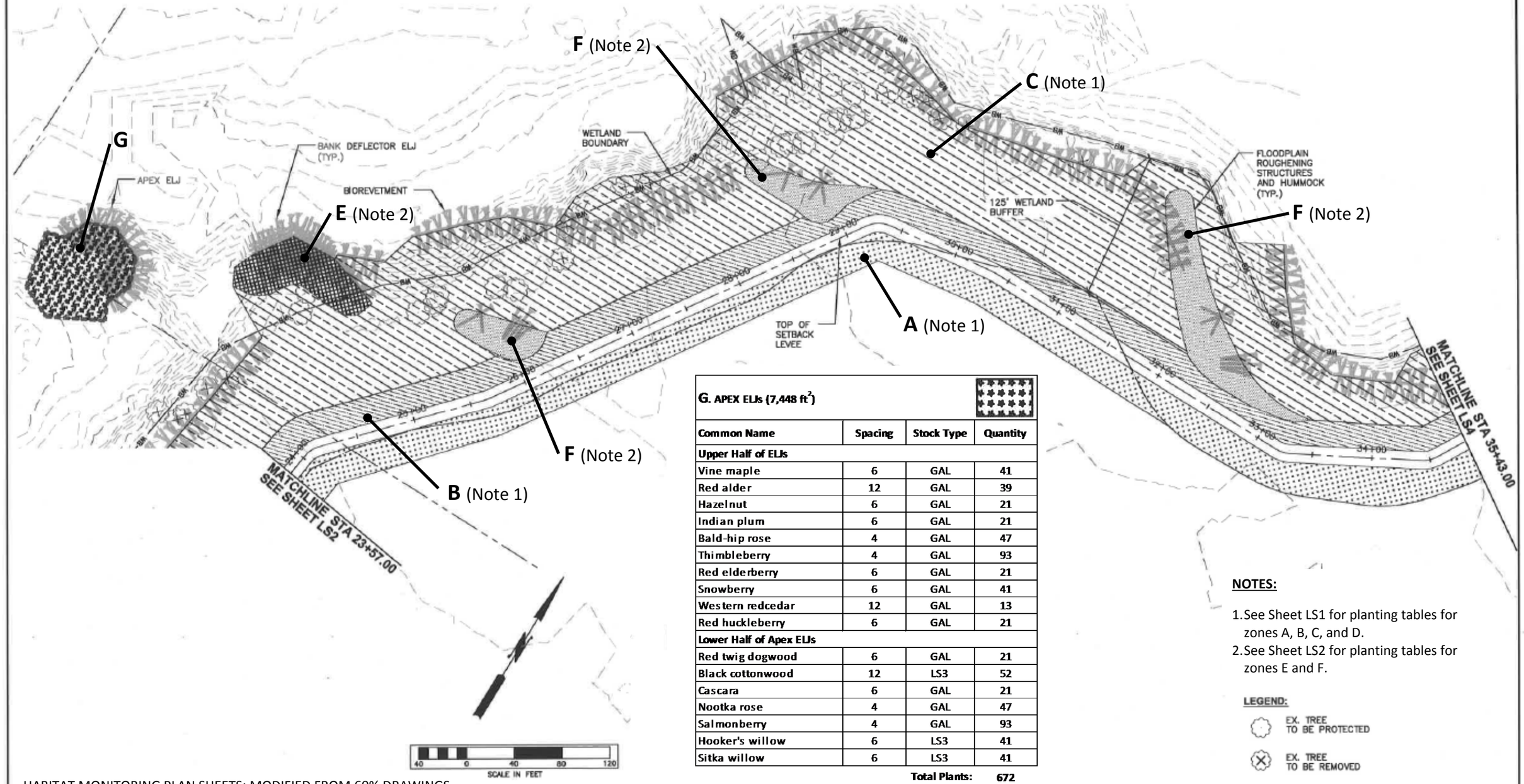
PLANTING PLAN

SHEET 63 OF 69 SHEETS
LS2



G. APEX ELJs (7,448 ft²)

Common Name	Spacing	Stock Type	Quantity
Upper Half of ELJs			
Vine maple	6	GAL	41
Red alder	12	GAL	39
Hazelnut	6	GAL	21
Indian plum	6	GAL	21
Bald-hip rose	4	GAL	47
Thimbleberry	4	GAL	93
Red elderberry	6	GAL	21
Snowberry	6	GAL	41
Western redcedar	12	GAL	13
Red huckleberry	6	GAL	21
Lower Half of Apex ELJs			
Red twig dogwood	6	GAL	21
Black cottonwood	12	LS3	52
Cascara	6	GAL	21
Nootka rose	4	GAL	47
Salmonberry	4	GAL	93
Hooker's willow	6	LS3	41
Sitka willow	6	LS3	41
		Total Plants:	**672**

NOTES:

1. See Sheet LS1 for planting tables for zones A, B, C, and D.
2. See Sheet LS2 for planting tables for zones E and F.

LEGEND:

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

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COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
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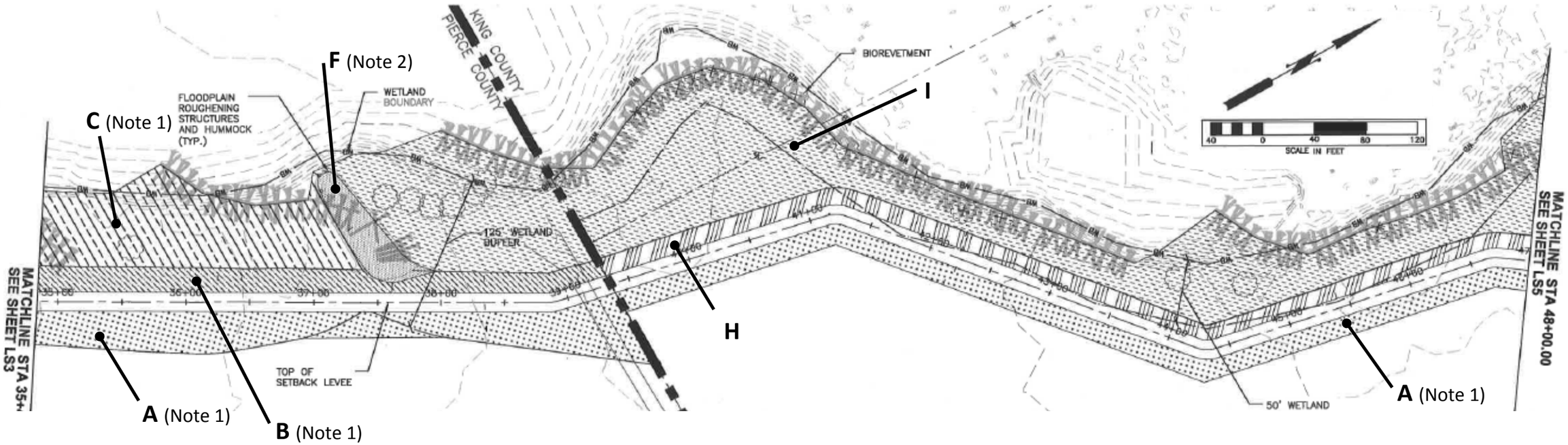
PLANTING PLAN

SHEET 64 OF 69 SHEETS
LS3



H. WATERWARD LEVEE SLOPE DRY (30,304 ft²)

Common Name	Spacing	Stock Type	Quantity
Vine maple	6	GAL	84
Big-leaf maple (Note 3)	25' L	GAL	45
Red twig dogwood	6	GAL	168
Hazelnut	6	GAL	84
Red fescue (Note 3)	14 lbs/ac	SEED	10
Oceanspray	6	GAL	84
Indian plum	6	GAL	84
Sword fern (Note 3)	4	GAL	189
Douglas fir (Note 3)	25' L	GAL	45
Cascara	6	GAL	84
Bald-hip rose	4	GAL	189
Thimbleberry	4	GAL	284
Snowberry	6	GAL	210
Fringe cup (Note 3)	4	POT	95
		Total Plants:	1,657

I. WETLAND BUFFER DRY (247,563 ft²)

Common Name	Spacing (Note 4)	Stock Type (Note 5)	Quantity
Big-leaf maple	10	SD, GAL	248
Black cottonwood	10	LS3	1,238
Douglas fir	10	PL, GAL	495
Red alder	10	SD, GAL	495
Cascara	6	SD, GAL	688
Scouler's willow	6	SD, LS3	688
Vine maple	6	TR, GAL	688
Bald-hip rose	4	SD, GAL	1,547
Hazelnut	6	TR, GAL	688
Indian plum	6	TR, GAL	688
Red huckleberry	6	GAL	688
Saskatoon	6	TR, GAL	688
Snowberry	6	TR, GAL	1,375
Thimbleberry	4	SD, GAL	1,547
Sword fern	4	GAL	1,547
		Total Plants:	13,307

NOTES:

1. See Sheet LS1 for planting tables for zones A, B, and C
2. See Sheet LS2 for planting table for zone F.
3. Plant big-leaf maple & Douglas fir alternately 25' o.c. in undulating line on mid-lower slope position. Seed first 3' of slope adjacent to road with red fescue; next 3' to be planted with sword fern and fringe cup.
4. Spacing is ft o.c. unless linear ft as indicated by "L." Trees to be planted 10 or 12 feet o.c. from other trees in planting unit as indicated. Shrubs to be planted 4 or 6 feet from other shrubs as indicated. Quantities are based on percent cover goals for each species , not spacing.
5. SD=seedling, TR=transplant, LS3=3' live stake, LS6=6' live stake, PL=plug, GAL=1-gallon container, POT= 4" pot, SEED=pound of seed. Where two stock types are indicated, split quantities in half for each type

LEGEND:

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

HABITAT MONITORING PLAN SHEETS: MODIFIED FROM 60% DRAWINGS.

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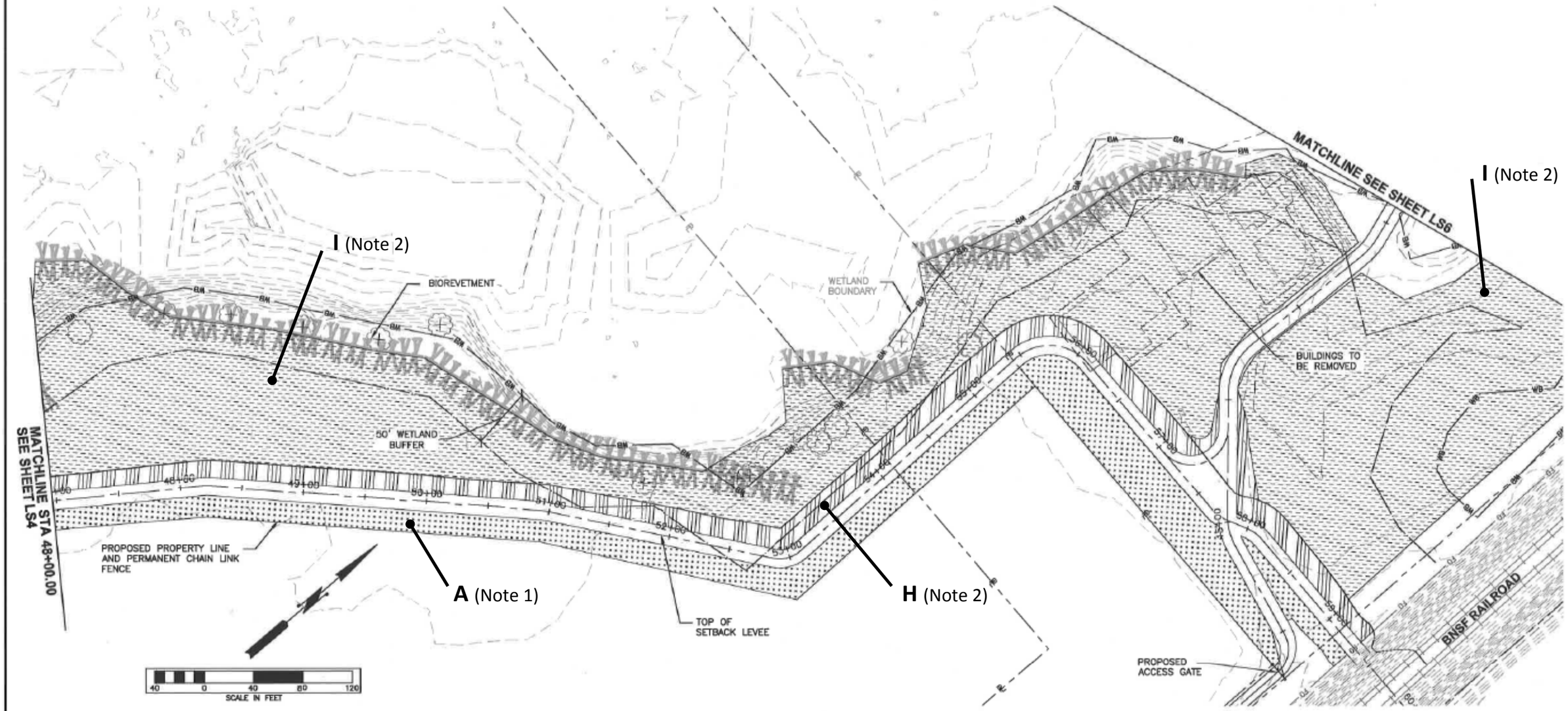
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION
PLANTING PLAN

SHEET 65 OF 69 SHEETS
LS4



NOTES:

1. See Sheet LS1 for planting tables for zone A.
2. See Sheet LS4 for planting tables for zones H and I.

LEGEND:

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

HABITAT MONITORING PLAN SHEETS: MODIFIED FROM 60% DRAWINGS.

FIELD BOOK:
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COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
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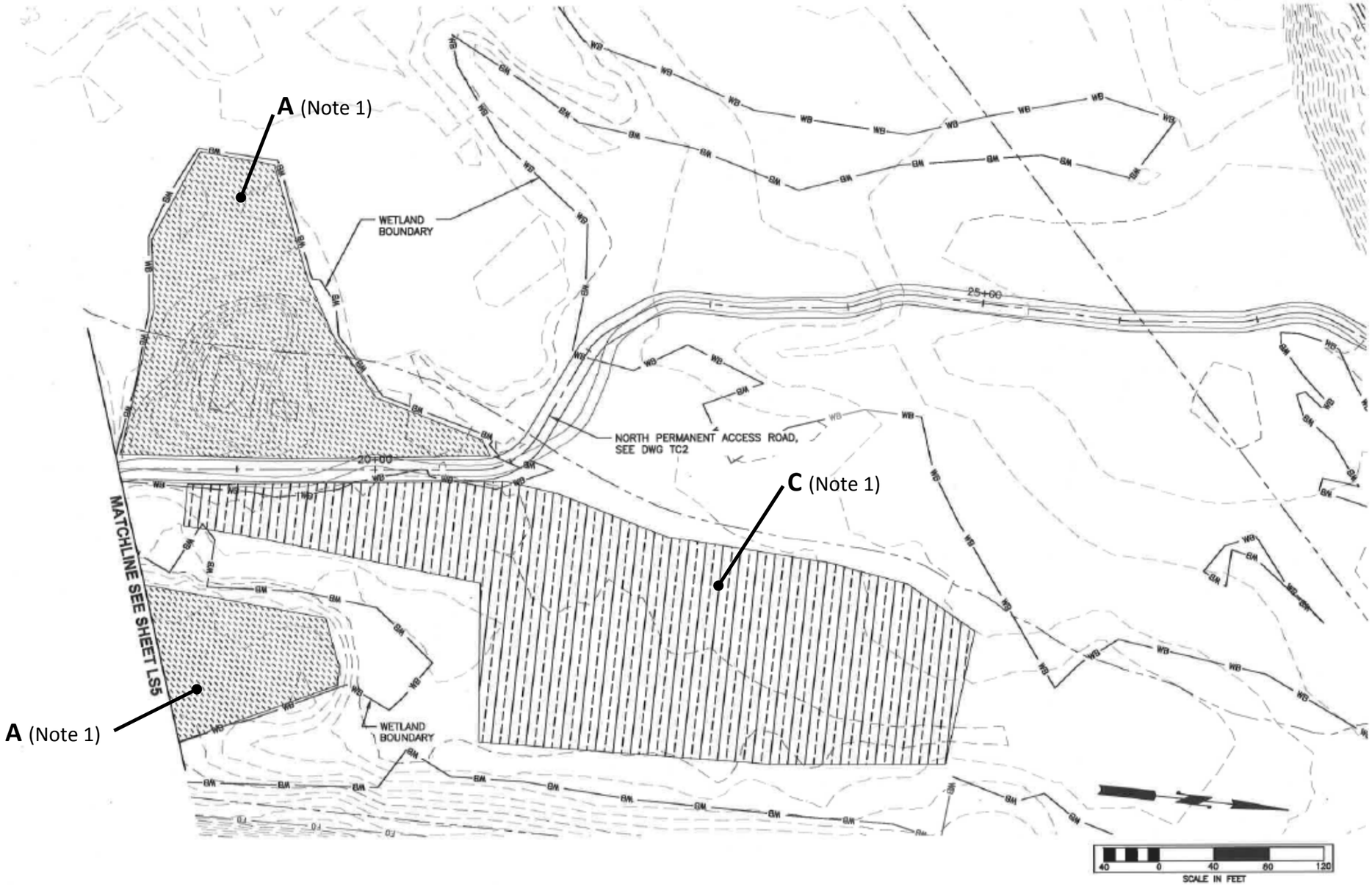
PLANTING PLAN

SHEET 66 OF 69 SHEETS

LS5



NOTES:

1. See Sheet LS1 for planting tables for zones A and C.

LEGEND:

- EX. TREE TO BE PROTECTED
- EX. TREE TO BE REMOVED

HABITAT MONITORING PLAN SHEETS: MODIFIED FROM 60% DRAWINGS.

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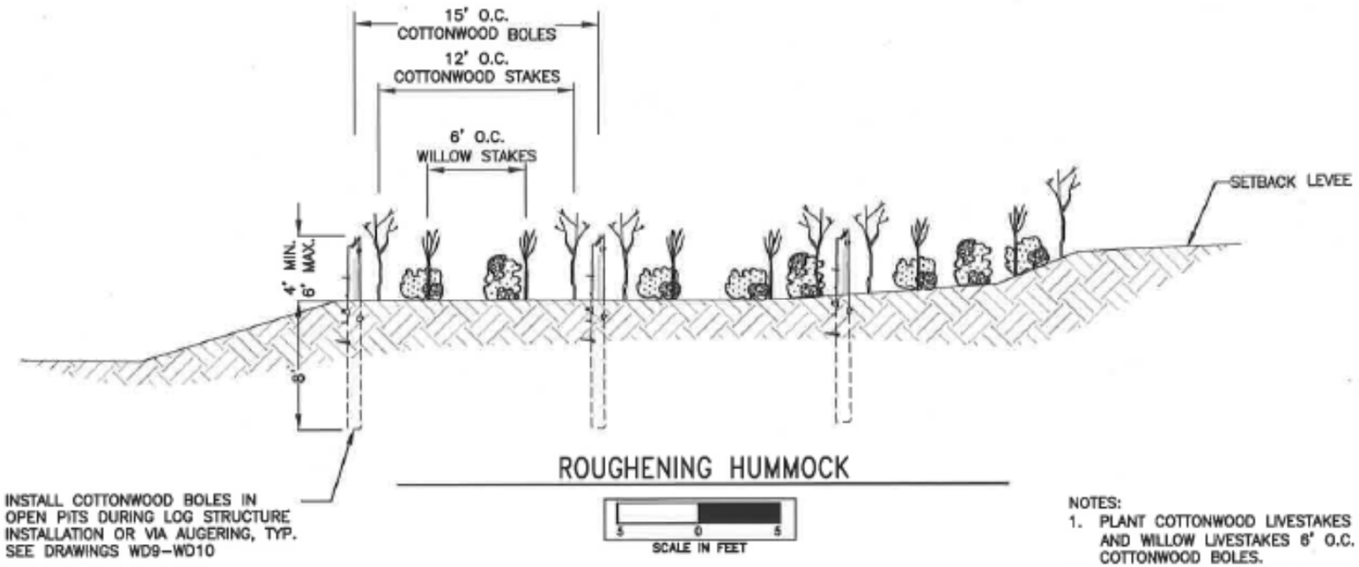
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION
PLANTING PLAN

SHEET 67 OF 69 SHEETS
LS6



ROUGHENING HUMMOCK

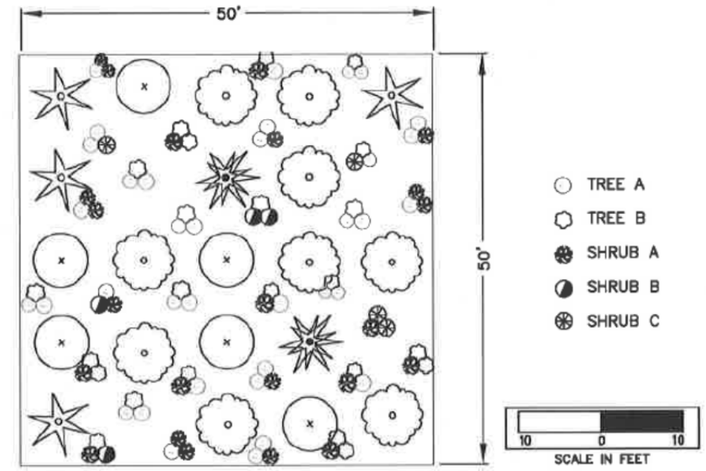
NOTES:
1. PLANT COTTONWOOD LIVESTAKES 12' O.C. AND WILLOW LIVESTAKES 6' O.C. AMONG COTTONWOOD BOLES.
2. PLANT SHRUBS 4'-6' O.C. IN CLUSTER GAP MOSAIC AS PER WETLAND BUFFER PLAN DETAIL.

GENERAL PLANTING NOTES:

1. BIOREVETMENT WILL BE PLANTED WITH TALL SHRUBS (WILLOWS & DOGWOOD) ALONG THE EDGE OF THE STRUCTURE IN GAPS BETWEEN LOGS.
2. THE WETLAND BUFFER WET/DRY WILL BE PLANTED WITH A MIX OF TREES AND SHRUBS. SEE WETLAND BUFFER WET/DRY TYP. DETAIL, THIS SHEET.
3. THE LEVEE TOP/ACCESS ROAD WILL BE COVERED WITH GRAVEL.
4. LEVEE BACK SLOPES WILL BE PLANTED WITH SHRUBS AND SELECT TREE SPECIES.
5. APPLY COMPOST IN THE LEVEL PLANTING AREAS AND 18" TOPSOIL ON LEVEE SIDE SLOPES AS SHOWN ON PLANS.

PLANTING NOTES:

1. PLANT TREES AT VARIABLE SPACING AVERAGING 10' O.C.
2. PLANT SHRUBS BETWEEN TREES IN CLUSTER-GAP MOSAIC.
3. SHRUBS TO BE SPACED 1'-2' APART IN CLUSTERS OF THREE, APPROXIMATELY 7'-9' APART.
4. EACH CLUSTER TO CONTAIN AT LEAST TWO DIFFERENT SPECIES.



WETLAND BUFFER WET/DRY
TYPICAL PLAN DETAIL

HABITAT MONITORING PLAN SHEETS: MODIFIED FROM 60% DRAWINGS.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

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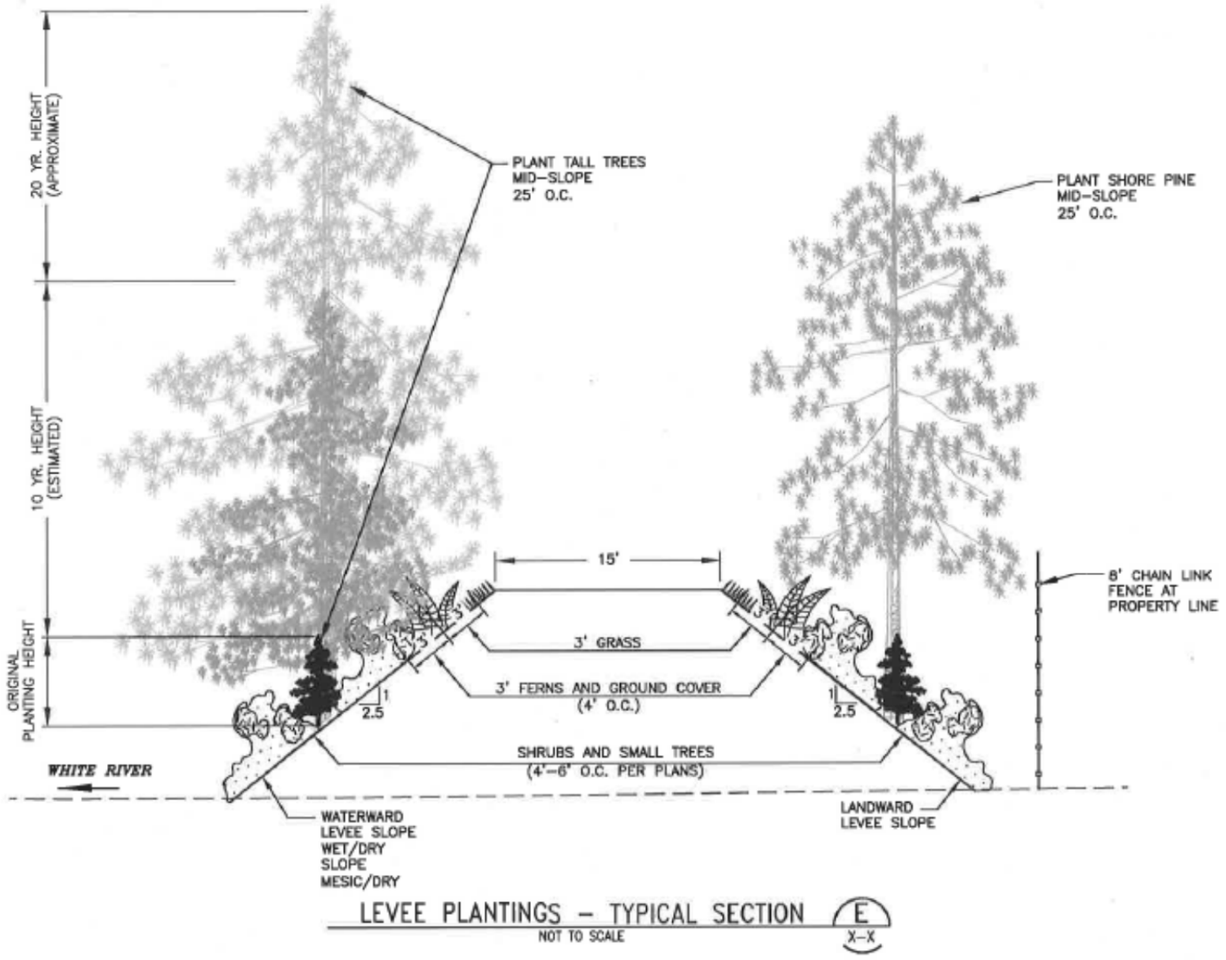
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

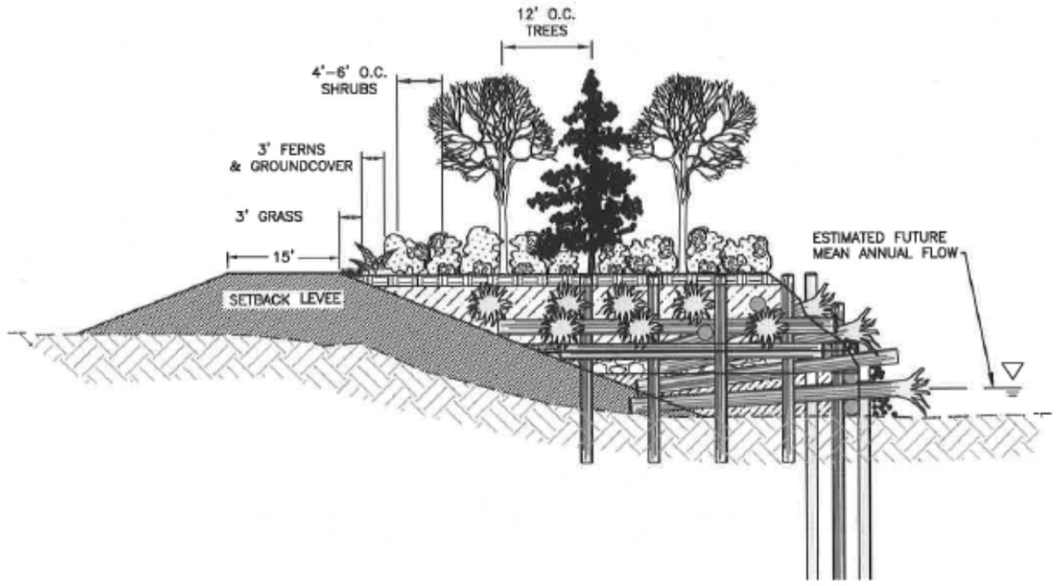
PLANTING DETAILS

SHEET 68 OF 69 SHEETS

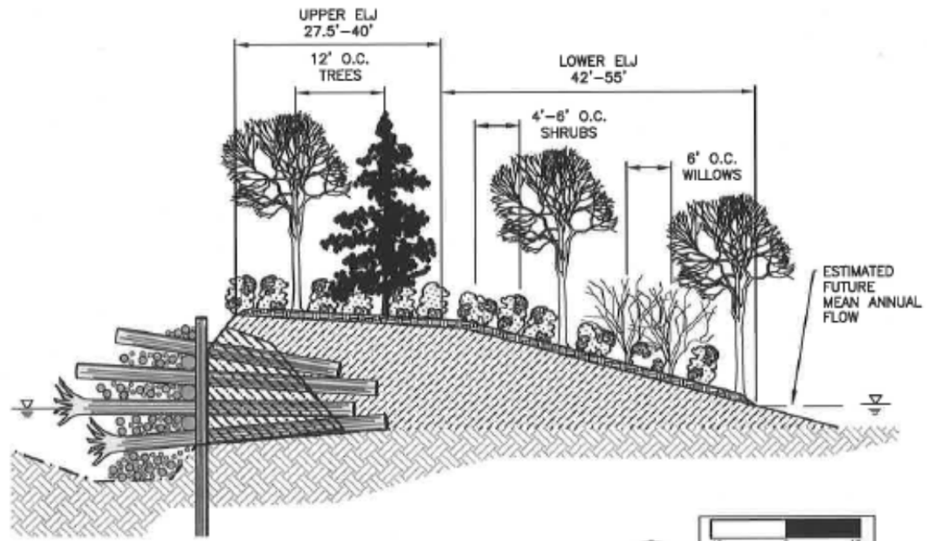
LS7



LEVEE PLANTINGS – TYPICAL SECTION (E, X-X)
NOT TO SCALE



BANK DEFLECTOR ELJ PLANTING-SECTION (X, X-X)



APEX ELJ PLANTING – SECTION (A, WO3)

NOTES:

1. See planting tables for plant spacing.
2. Plant "upper half ELJ" species and "lower half ELJ" species above and below slope break, respectively.

HABITAT MONITORING PLAN SHEETS: MODIFIED FROM 60% DRAWINGS.

FIELD BOOK:
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SHEET 69 OF 69 SHEETS
LS8